SELF CONTAINED FOAM DISPENSER

RELATED APPLICATIONS

The present application claims the benefit under 35 U.S.C. 119(e) of US provisional application 60/556,883, titled "Hand-Held Dispenser", filed March 29, 2004, the disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates to foam dispensers and particularly to hand held foam dispensers.

BACKGROUND OF THE INVENTION

Foam materials are commonly used for packaging. The foam is generally generated by mixing two chemical components, which harden within about 10-30 seconds. In many cases, a foam dispensing gun is used to generate the foam at the packaging site. U.S. patent 4,262,848 to Chabria and U.S. patent 5,462,204 to Finn, the disclosures of which are incorporated herein by reference, describe such guns which are connected through tubes to large containers including the chemicals used in forming the foam. The dispensing gun generally includes a pair of pumps which pump the chemicals out of the containers at precise required amounts in order to achieve a proper mix. In addition, the chemicals may be heated in order to achieve a better mix reaction.

U.S. patent 3,178,157 to Cole, the disclosure of which is incorporated herein by reference, describes a compact foaming apparatus for various tasks, such as inflating a raft. The foaming apparatus includes two tanks which receive flexible bags that carry the chemicals to be mixed in forming the foam. A pressure source is used to compress the bags and cause the chemicals to leave the bags.

U.S. patent 6,691,898 to Hurray et al., the disclosure of which is incorporated herein by reference, describes a hand-held dispensing apparatus for urethane foams, which is claimed to allow one handed operation. The apparatus includes a pen-shaped dispenser connected through tubes to a pair of chemical containing pressurized containers. A button on the pen-shaped dispenser is used to actuate release of the chemicals from the pressurized containers.

U.S. patent 5,348,392 to Bouquet et al., the disclosure of which is incorporated herein by reference, describes a hand-held apparatus for mixing two chemicals from two separate receptacles. The apparatus includes piercing means for piercing the receptacles, a mixing chamber and a passageway for expelling the foam. The apparatus is used for medical purposes

and is actuated by direct mechanical pressure of a user on the receptacles to extract the chemicals therefrom.

The above hand-held apparatus are generally inaccurate in the proportions of chemicals they mix and provide a low quality foam mix.

As foam materials harden within a short time, remnants of the foam may harden within the dispensing apparatus and clog flow passageways.

U.S. patent 6,079,868 to Rydell, the disclosure of which is incorporated herein by reference, describes a hand-held device for mixing and delivering a curable biomaterial in a minimally invasive medical procedure. In one embodiment of Rydell, the device pumps the chemicals it mixes from remote containers connected through tubes to the device. In another embodiment of Rydell, the device has containers mounted on it and the chemicals are extracted using pressure. The materials used for generating foam are different from those used in biomedical applications. In addition, a delivery conduit is required in medical applications but not in packaging applications. The Rydell device uses a relatively long static mixer for mixing the chemicals, which needs to be replaced after every use.

SUMMARY OF THE INVENTION

A general aspect of some embodiments of the invention relates to a self-contained foam dispensing device, i.e., a dispensing device having chemical containers mounted on or included in the device, which provides high quality foam mixing. The dispensing device optionally allows intermittent use in small amounts over a relatively long period, with reduced waste and/or reduced element replacement costs. Optionally, the compact dispensing device is hand-held, along with foam chemical containers.

An aspect of some embodiments of the invention relates to a self-contained dispensing device for generating foam, which includes at least one pump, or other flow generator, located between the chemical containers and a mixing chamber of the device. The pump between the chemical containers and the mixing chamber provides more accurate and/or efficient operation, than provided by pressure units for pushing chemicals out of their containers, located behind the containers. In addition, using a pump between the containers and the mixing chamber allows use of non-rigid containers such as plastic bags or elastic bags. Having the pump between the containers and the mixing chamber also allows for a more compact dispensing device and allows simpler replacement of the pump and the mixing chamber in cases of problems. In some embodiments of the invention, the pump is connected to a nozzle defining the mixing chamber.

In some embodiments of the invention, the at least one pump at least partially sucks the chemicals used in generating the foam out of the chemical containers. Pumping the chemicals out of their containers allows, in some cases, more accurate control of the mixed quantities, than pushing the chemicals out of their containers. In some embodiments of the invention, the self-contained dispensing device includes at least one metering pump. Alternatively or additionally, the at least one pump includes a gear pump. In some embodiments of the invention, the pump comes in contact with the chemicals. Alternatively, the pump operates without any of its parts coming in contact with the chemicals, for example, the pump may comprise a peristaltic pump.

In some embodiments of the invention, the pumping provides accurate chemical amounts with an error of up to about 2-5% of the pumped amount, or even less. Pumping the chemicals also allows easily reaching high pressure levels, which can be used for high quality mixing of the chemicals. Furthermore, using pumping reduces the amount of chemical remnants settling along the chemical paths in the dispensing device. In some embodiments of the invention, a pushing mechanism is used in addition to the pumping. The pushing mechanism optionally provides a coarse force applied to the chemicals, while the pumping provides the accurate control of the chemical mix. In some embodiments of the invention, the pushing mechanism is used only when a new container is used, in order to remove any air between the chemicals and the pump and start the pumping from a new container. Alternatively or additionally, the pushing mechanism operates whenever the dispensing device is operated, in order to remove any air bubbles, which may interfere with the pumping, from the chemicals.

In some embodiments of the invention, the self contained dispensing device includes a heater, which heats the chemicals used in generating foam, to an optimal temperature level for the foam creation.

Optionally, the self-contained dispensing device is a hand-held device. Optionally, the dispensing device can be held and operated using only one hand. In some embodiments of the invention, the device is worn on the user's hand and/or includes a support structure for placing the dispensing device on the user's arm. The device is optionally light weight, for example having a weight of less than 5 kilograms including the chemical containers mounted in the device. Optionally, when using small chemical containers, the dispensing device including the chemical containers has a weight of less than 3 kilograms or even 2 kilograms. In some

embodiments of the invention, the device has small dimensions, optionally having a longest dimension of less than 40-60 centimeters or even less.

In other embodiments of the invention, the dispensing device is a table mounted device or a wall mounted device.

In some embodiments of the invention, the device includes substantially closed compartments which receive the chemical containers, such that during use of the device, the chemical containers are not seen by the user. Optionally, the closed compartments are adapted to receive containers of different sizes, for example by limiting the number of faces of the compartments to which the chemical containers are connected. In some embodiments of the invention, the chemical containers connect only to a single face of the compartments in which they reside. Alternatively to including the chemical containers in closed compartments, the chemical containers are mounted externally on the dispensing device. In some embodiments of the invention, the device does not include tubes that are external to a housing of the device. Thus, there is no need to drag tubes and/or no need to be careful to avoid external tubes getting stuck on bulging objects. Furthermore, having very short internal tubes, if at all, reduces the chances of tubes getting clogged.

The chemical containers are optionally rigid, so that their handling is simpler than the handling of bags. Optionally, the end of the container opposite an outlet from the container (or a side) is movable, to allow pushing the contents of the container toward the outlet from which the chemical is pumped. Alternatively, chemical bags are used, as bags are generally cheaper than rigid containers.

An aspect of some embodiments of the invention relates to a foam dispensing device having a permanently usable base portion which does not come in contact with the chemicals used to generate the foam (even before they are mixed) and a detachable portion which includes all the parts that come in contact with the chemicals. The detachable portion is optionally adapted for easy release and replacement, for example without using tools and/or without requiring substantial application of force. Optionally, the entire detachable portion can be replaced together as a single part. In some embodiments of the invention, the detachable portion is replaceable using a single hand, for example when the base portion is table mounted.

In some embodiments of the invention, the detachable portion is formed of inexpensive disposable materials. In an exemplary embodiment of the invention, the detachable portion is formed substantially only from plastic.

The base portion of the dispensing device optionally includes a motor which provides the power for inducing the flow of chemicals into the mixing chamber. Alternatively or additionally, the base portion includes at least one heater, for heating the chemicals. In some embodiments of the invention, the base portion includes a control panel and/or a controller which controls the operation of the dispensing device. The base portion optionally includes batteries and/or a power transformer for operating the dispensing gun.

In some embodiments of the invention, the detachable portion includes a nozzle in which the chemicals are mixed and one or more pumps or other flow generator which induces the flow of the chemicals into the mixing chamber. Possibly, the detachable portion further includes at least one container of chemicals which is an integral part of the detachable portion. Optionally, kits including replacement detachable portions are provided within stand alone packages. The kits optionally include all the elements of the detachable portion connected to each other, such that there is no need to assemble the detachable portion before connecting the detachable portion to the base portion.

An aspect of some embodiments of the invention relates to a replacement part kit for a dispensing gun, which includes both a flow generator (e.g., a chemical pump or suction unit) and a mixing chamber. Optionally, the flow generator and mixing chamber are attached within the kit. In some embodiments of the invention, the flow generator and mixing chamber are not adapted for separation without tools.

An aspect of some embodiments of the invention relates to a self-contained dispensing device for generating foam, which has a detachable portion in which the chemicals forming the foam mix together. The detachable portion allows fast replacement of elements of the dispensing device that were clogged by settling foam. Optionally, a single detachable portion of the dispensing device includes all the elements of the device that come in contact with the chemicals after they are mixed and/or on which hardened foam remnants may settle. The remaining parts of the dispensing device are optionally designed for long term use. Optionally, the remaining parts include relatively expensive elements, such as a heater, a motor and/or electronic circuits.

An aspect of some embodiments of the invention relates to a heating base for storing and pre-heating chemical containers used in generating foam. The heating base optionally pre-heats the containers so that the time required to warm the chemicals within a dispensing gun is short and/or the energy consumption for heating by the dispensing device is low. In some embodiments of the invention, the heating base also has a receptacle adapted to receive the

dispensing gun. Optionally, the heating base has one or more receptacles adapted to receive relatively small chemical tanks, for example having a content of less than 10 liters, less than 5 liters or even less than 2 liters.

An aspect of some embodiments of the invention relates to a foam dispensing device adapted to receive chemical containers having a port with a flexible and/or elastic valve. The elastic valve prevents chemicals from exiting the container unless a matching tube leading the chemical to a mixing chamber of the dispensing device is properly positioned in the valve.

An aspect of some embodiments of the invention relates to a self contained chemical bag for producing a foam. The bag includes at least two compartments which separately store chemicals used in generating the foam, and a third compartment in which the chemicals are mixed. In some embodiments of the invention, the bag includes a nozzle between the mixing compartment and the chemical compartment, which nozzle controls the mixing of the chemicals, to achieve a high quality mix. In some embodiments of the invention, one or more disposable pumps are included in the nozzle. The use of self-contained bags allows cleaner operation of foam generation, as the entire mixing of the chemicals may occur within the bag.

There is therefore provided in accordance with an exemplary embodiment of the invention, a self-contained foam dispensing device, comprising a casing, a mixing chamber, a port adapted to receive one or more containers including a plurality of chemicals in a plurality of compartments, such that when the one or more containers are in the port the one or more containers move with movement of the casing and a flow generator adapted to induce flow of chemicals from the compartments toward a mixing chamber, the flow generator being located between the mixing chamber and the port.

Optionally, the flow generator comprises a pump. Optionally, the dispensing device is designed to be hand held, with the one or more containers, by a user. Optionally, the one or more containers comprise two containers. Optionally, the one or more containers comprise a single container divided into a plurality of compartments. Optionally, the casing defines one or more recesses adapted to receive the containers within the casing. Optionally, the recesses are adapted to receive containers of a plurality of different sizes, operatively connected to the port.

Optionally, the dispensing device with the one or more full containers, weighs less than 5 kilograms. Optionally, the flow generator comprises separate pumps for each of the chemicals. Optionally, the flow generator includes one or more sets of suction gears. Optionally, the flow generator pumps the chemicals out of the containers at different rates. Optionally, the chemicals pumped by the flow generator reach a pressure above 5 atmospheres.

Optionally, the device includes one or more heaters adapted to heat the chemicals in the containers. Optionally, the device includes one or more heaters adapted to heat the chemicals flowing from the containers. Optionally, the mixing chamber is detachably attached to the casing. Optionally, the device includes a nozzle through which the mixed chemicals are released to the environment. Optionally, the nozzle comprises a material to which foam does not substantially adhere. Optionally, the walls of the nozzle are flexible. Optionally, the nozzle is usable over a plurality of separate foam generating sessions. Optionally, the compartments are substantially rigid. Optionally, the mixing chamber is defined by flexible walls.

Optionally, the mixing chamber is expanded by the pressure of streams of chemicals pumped from the containers. Optionally, the mixing chamber is expanded from a substantially zero volume when the suction unit is not operating to a larger volume, when the section unit is operating. Optionally, the device includes at least one pressure valve along the path from the containers to the mixing chamber. Optionally, the device includes at least one pusher adapted to push the chemicals in the at least one container toward an exit of the container.

There is further provided in accordance with an exemplary embodiment of the invention, a foam dispensing device, comprising a casing, a port adapted to receive one or more containers including a plurality of chemicals in a plurality of compartments, and a detachable foam mixing chamber, easily detachable from the casing without use of tools, in which chemicals from the plurality of compartments are mixed, the dispensing device with the one or more containers is hand held.

Optionally, substantially all portions of the dispensing device that come in contact with the chemicals after they are mixed are included in a single detachable element with the mixing chamber. Optionally, the device includes a heater for heating the chemicals in the compartments. Optionally, the device includes a motor within the casing which operates one or more pumps to pump the chemicals from the compartments to the mixing chamber.

There is further provided in accordance with an exemplary embodiment of the invention, a base for a foam dispensing device, comprising a niche for receiving the dispensing device, a battery charger adapted to charge a battery of the dispensing device while the dispensing device is in the niche, at least one compartment for receiving a container including a chemical used in generating foam by the dispensing device and a heater adapted to heat the contents of the container in the at least one compartment.

Optionally, the base includes at least one storage compartment for receiving a chemical container, wherein the chemical in the container in the storage compartment is not substantially heated while in the storage compartment.

There is further provided in accordance with an exemplary embodiment of the invention, a bag for generating foam, comprising a plurality of bag chemical compartments separately including chemicals which mix together into foam, an empty bag compartment and a nozzle coupled to the bag adapted to lead the chemicals from the plurality of chemical compartments to the empty compartment in a manner which causes the chemicals to mix and turn into foam. Optionally, the bag includes a disposable pump coupled to the bag. Optionally, the empty compartment has a sufficient volume to accommodate foam generated by mixing most of the chemicals in the plurality of chemical compartments.

Optionally, the bag includes at least one tube leading from the chemical compartment to the empty compartment, which tube is adapted to operate with a peristaltic pump.

There is further provided in accordance with an exemplary embodiment of the invention, a foam dispensing device, comprising a mixing chamber, a flow generator adapted to induce flow of chemicals to the mixing chamber, the flow generator being included in a single replaceable part with the mixing chamber; and a base portion, including a motor, which base portion only includes elements that do not come in contact with the chemicals.

Optionally, the base portion includes a heater. Optionally, the single replaceable part is detachable from the base portion without use of tools.

BRIEF DESCRIPTION OF THE DRAWINGS

Particular exemplary embodiments of the invention will be described with reference to the following description of embodiments in conjunction with the figures, wherein identical structures, elements or parts which appear in more than one figure are generally labeled with a same or similar number in all the figures in which they appear, in which:

Fig. 1 is a schematic illustration of a foam generating and dispensing system, in accordance with an exemplary embodiment of the invention;

Fig. 2 is a cross-sectional view of a dispensing gun, in accordance with an exemplary embodiment of the invention;

Fig. 3 is a schematic view of elements forming a suction unit, in accordance with an exemplary embodiment of the invention;

Fig. 4 is a cut away assembled schematic view of a suction unit and a nozzle, in accordance with an exemplary embodiment of the invention;

Figs. 5A and 5B are cross-sectional views of an exit portion of the dispensing gun of Fig. 2, in accordance with an exemplary embodiment of the invention;

Fig. 6 is a schematic view of a nozzle of a dispensing gun, in accordance with another exemplary embodiment of the invention;

Fig. 7 is a schematic illustration of a dispensing system, in accordance with another exemplary embodiment of the invention;

Fig. 8 is a schematic view of a stand for a foam dispensing gun, in accordance with an exemplary embodiment of the invention;

Fig. 9 is a schematic illustration of a table-mounted self-contained foam dispensing device, in accordance with an exemplary embodiment of the invention;

Figs. 10A and 10B illustrate a chemical container port for use in a dispensing device, in closed and open states, respectively, in accordance with an exemplary embodiment of the invention; and

Fig. 11 is a schematic illustration of a foam generation machine, in accordance with an exemplary embodiment of the invention.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

Fig. 1 is a schematic illustration of a foam generating and dispensing system 100, in accordance with an exemplary embodiment of the invention. System 100 comprises a base 110 which includes a recess 112 sized and shaped to receive a hand-held foam dispensing gun 120. Optionally, a battery (not shown) of gun 120 is charged when the gun is properly placed in recess 112. Base 110 optionally further includes a plurality of recesses 130 adapted to receive chemical containers, and heat the containers while they are in the recesses. In an exemplary embodiment of the invention, recesses 130 host containers 132 of a chemical A, e.g., and containers 134 of a chemical B. In an exemplary embodiment of the invention, chemical A comprises a polymeric isocyanate or a fluorocarbon, while chemical B comprises polyols, catalysts or flame retardants. It is noted, however, that system 100 is not limited to use with any specific chemicals and has advantages which are useful for mixing many chemicals. Particularly, the materials from which system 100 is formed are optionally selected according to the chemicals being mixed. Alternatively or additionally, the size of containers 132 and 134 may be selected according to the specific chemicals used. For example, rather than using containers of same sizes, containers of different sizes may be used, according to the mixing ratio of the chemicals or to prevent placing the containers in the wrong compartments.

Optionally, a switch 140 is used to activate the heating in recesses 130. In some embodiments of the invention, the heating is applied to all the recesses 130. Alternatively, the heating is applied only to a single pair of recesses 130 which are known by the operator, such that the operator takes replacement containers from those recesses. The heating optionally brings the chemicals to an optimal temperature for improved mixing viscosity. Alternatively, the heating brings the chemicals to a temperature lower than optimal and the remaining temperature increase is completed within gun 120. In some embodiments of the invention, the containers 132 and 134 are heated in recesses 130 to a temperature which does not prevent the user from holding the containers and loading them into gun 120. Optionally, the heating in base 110 is controlled by a thermostat. Alternatively, the heating is performed, for simplicity, without a controller.

Gun 120 includes a housing 160 with a removable cover 162, which allows replacing containers 132 and 134 as described hereinbelow. Optionally, gun 120 includes a handle 164 for holding gun 120 and an activation trigger 166 on handle 164. In some embodiments of the invention, a stabilization structure 150 protrudes from the bottom side 168 of gun 120 spaced from handle 164. When held by a user, structure 150 optionally rests on the user's arm, thus stabilizing gun 120 on the user's arm and allowing for accurate aiming of the foam released from the gun, while gun 120 is held with only one hand. In some embodiments of the invention, gun 120 weighs less than 5 Kg, or even less than 3 Kg when containers 132 and 134 are full. In an exemplary embodiment of the invention, gun 120 has dimensions of about 50 X 18 X 8 centimeters.

In some embodiments of the invention, gun 120 includes a control panel 170 which allows a user to set various operation attributes of the gun. Alternatively or additionally, the operation attributes of gun 120 can be set from a control panel not on gun 120, for example a control panel on base 110, on a computer (not shown) connected to base 110 or on a remote control. Control panel 170 may include, for example, mixing ratios of the chemicals, the heating temperature and/or the desired operation rate. Alternatively or additionally to allowing the setting of operation attributes, control panel 170 displays the status of gun 120, such as the charging level of the battery and/or the remaining amount of chemicals in the containers.

Alternatively to using stabilizing structure 150, gun 120 may include a strap or a rigid bracelet which is used to connect the gun to the user's arm. Further alternatively or additionally, handle 164 is replaced by an indention, a ring, a strap and/or any other holding

and/or attachment mechanism. Gun 120 optionally has a structure that allows it to be easily balanced on the user's hand,

Fig. 2 is a cross-sectional view of gun 120, in accordance with an exemplary embodiment of the invention. Gun 120 includes a body section 202 adapted to receive containers 132 and 134. A plurality of heating elements 206 optionally surround containers 132 and/or 134 so as to heat the contents of the containers to an optimal temperature for foam generation. A suction unit 210 pumps the chemicals from containers 132 and 134 through channels 212 and 214, respectively. The chemicals are mixed and ejected through a nozzle 220. Optionally, the mixing of the chemicals is performed within a cavity defined in an exit unit 392 (Figs. 5A and 5B) within suction unit 210. When gun 120 is operated, motor 260 optionally rotates a driving shaft 262, which in turn powers the suction, as described below with reference to Fig. 3.

In some embodiments of the invention, containers 132 and 134 have moving rear walls 232 and 234, which are pushed by respective screws 226 and 228, so that sufficient chemical amounts within containers 132 and 134 are located adjacent channels 212 and 214. A screw motor 240 optionally actuates the movement of screws 226 and 228. The force applied by screw motor 240 to screws 226 and 228 is not intended to override the operation of suction unit 210, but rather only forces the chemicals within containers 132 and 134 toward the inlets of suction unit 210. Screws 226 and 228 optionally achieve a relatively low flow pressure, while suction unit 210 achieves a higher pressure at its exit. In some embodiments of the invention, a clutch mechanism (not shown) disconnects motor 140 from one or both of screws 226 and 228 when the force from the motor is not required in one or both of the containers. Optionally, screw motor 240 operates whenever suction unit 210 is operated. Alternatively, screw motor 240 operates only when suction unit 210 encounters problems in pumping sufficient material. Alternatively to using separate motors 240 and 260, a single motor is used to rotate both shaft 262 and screws 226 and 228.

Alternatively or additionally to using screw motor 240 and/or screws 226 and 228, other mechanisms for pushing the chemicals in containers 132 and 134 toward suction unit 210 may be used, such as one or more springs.

In some embodiments of the invention, gun 120 is powered by a battery 282. Alternatively or additionally, gun 120 is powered by a connection to an electrical socket.

Body section 202 may be configured to receive containers 132 and 134 of only a single size. Alternatively, body section 202 is adapted to receive containers 132 and 134 of a

plurality of different sizes. Thus, the consumer can choose the container size to be used, according to the expected amount of foam he/she will require in the near future. It is noted, however, that even after containers 132 and 134 are opened, there is no problem leaving them unused for a few days and they can be used again immediately thereafter. In some embodiments of the invention, the containers 132 and 134 have different sizes and/or different ports, to avoid connecting the wrong container to one or both the ports.

Fig. 3 is a schematic view of the elements forming suction unit 210, in accordance with an exemplary embodiment of the invention. Suction unit 210 includes three boards 310, 312 and 314, which hold the various moving elements of suction unit 210. Driving shaft 262 optionally passes through holes 316 and 318 in boards 310 and 312 to a first set of suction gears 322 and 324, which pump a chemical from container 134. Gears 352 and 354 between boards 310 and 312 transfer the rotation force of shaft 262 to a second set of suction gears 362 and 364, which pump a chemical from container 132. In some embodiments of the invention, the ratio between gears 352 and 354 defines the ratio of the volume of the chemicals pumped from containers 132 and 134.

Suction gears 322 and 324, as well as suction gears 362 and 364, optionally operate in accordance with the operation methods of gear metering pumps known in the art. Optionally, the suction gears have a relatively high accuracy with an error level of up to about 2-5%, for example 3%, of the desired pumped quantities. The chemicals from containers 132 and 134 enter suction unit 210 through channels 372 and 374 optionally carved in board 314 and through respective holes in boards 310 and 312. From channels 372 and 374, the chemicals pass through mesh gears and holes 382 and 384 into a mixing chamber defined between a circular unit 390 and exit unit 392, which includes nozzle 220.

Fig. 4 is a schematic cut-open view of suction unit 210 (Fig. 3), circular unit 390 and exit unit 392, in accordance with an exemplary embodiment of the invention. In Fig. 4, circular unit 390 is shown in place within boards 312 and 314. An internal piece 393 sits within circular unit 390 and attaches to exit unit 392. In addition, Fig. 4 shows the path leading from hole 382, through a bore 389, to a channel between internal piece 393 and exit unit 392, as discussed below with reference to Fig. 5A.

Fig. 5A is a cross-sectional view of circular unit 390, internal piece 393 and exit unit 392, in accordance with an exemplary embodiment of the invention. During operation, the chemical flow in bore 389 enters a narrow channel 516 passing within exit unit 392. Similarly, the chemical from the other container flows into a narrow channel 514, within exit unit 392.

The chemical flows exit narrow channels 514 and 516 near a tip 510 of internal piece 393, and press against a valve defined by opposite lips 508 of exit unit 392. The pressure on lips 508, due to high pressure from the pumps, causes lips 508 to separate, as shown in Fig. 5B, which is a variation of Fig. 5A in which the pressure of the chemicals form at least a portion of a mixing chamber 598. The chemicals from narrow channels 514 and 516 enter mixing chamber 598 and mix together. From mixing chamber 598, the mixed chemicals flow out nozzle 220 into their desired packing location according to the direction of gun 120. When suction gears 322 and 324 stop their operation, the pressure on lips 508 stops and they return back into their closed position (Fig. 5A), preventing settling of foam within mixing chamber 598.

Lips 508 serve as flexible walls which define mixing chamber 598, when the walls are expanded by the pressure of the chemicals exiting narrow channels 514 and 516. A potential advantage of using a flexible wall is that it reduces the amount of mixed chemicals that can settle within chamber 598 and hence the amount of foam remnants hardening in chamber 598 is small. In some embodiments of the invention, exit unit 392 may be used for a plurality of foam dispensing sessions, which occur at different times separated by hours, days or even weeks. In addition, lips 508 serve as a valve which prevents dripping of material when suction unit 210 stops operating.

In some embodiments of the invention, when the chemicals are not pumped out of the containers, the volume of mixing chamber 598 is substantially zero, due to the return of lips 508 back into their rest position (Fig. 5A). Alternatively, the closing of lips 508 closes a portion of chamber 598 nearer channels 514 and 516. The remaining portion of chamber 598 is open to the environment. Optionally, any settling of foam in nozzle 220 can be easily removed by pressing the walls of nozzle 220 by a human operator. As shown in Figs. 5A and 5B, the streams in narrow channels 514 and 516 are not directed at lips 508 but rather at tip 510. Therefore, a relatively high chemical pressure is required in order to open a passageway to mixing chamber 598. In other embodiments of the invention narrow channels 514 and 516 are more directly pointed at lips 508, thus reducing the pressure level required in order to open the lips.

In some embodiments of the invention, the high pressure of the chemical streams has a double purpose. On the one hand, the pressure opens mixing chamber 598 and the path out of suction unit 210 to nozzle 220. On the other hand, the pressure is used in achieving a high quality mix of the chemicals.

Nozzle 220 is optionally formed of a flexible but durable material, such that the walls of nozzle 220 can be pressed together in order to remove foam remnants that settled in the nozzle, if such remnants remain. In some embodiments of the invention, nozzle 220 is elastic. The pressing generally grinds the foam remnants or at least causes them to detach from the nozzle. Alternatively or additionally, nozzle 220 is formed of a material to which foam remnants do not stick or at least have a relatively weak bonding. In an exemplary embodiment of the invention, nozzle 220 is formed of Teflon, delarin and/or polypropylene. In other embodiments of the present invention, polypropylene, polyethylene and/or silicon are used.

Nozzle 220 is optionally flared in order to minimize the settling of the mixed chemicals on walls of the nozzle. In some embodiments of the invention, nozzle 220 has two parallel relatively rigid walls 398 (Fig. 3), connected by two more flexible walls. When pressed on, the flexible walls move and collapse, while the rigid walls compress the foam remnants. In some embodiments of the invention, flexible walls 396 (Fig. 3) have a central folding line 397 (Fig. 3). Alternatively, nozzle 220 has a circular and/or conical shape. Nozzle 220 has an expanding shape toward its outlet to the environment, so that it is relatively easy to remove foam remnants from the nozzle (e.g., by allowing simple access with a screwdriver or other tool) and hardening foam remnants are not caught tightly between the walls of the nozzle. Optionally, nozzle 220 does not include corners and/or enclaves in which foam remnants can settle. Nozzle 220 optionally has a length and/or width sufficiently large to receive the fingers of a user and allow the user to press against the walls in order to remove foam remnants therefrom.

In some embodiments of the invention, exit unit 392 is designed to allow fast release and connection of exit unit 392 from and to circular unit 390. Alternatively or additionally, exit unit 392 and circular unit 390 are designed to allow their fast connection and/or release from and to the remaining portion of suction unit 210. Circular unit 390 and/or exit unit 392 are optionally easily replaced, when necessary, for example due to clogging by settlement of foam remnants.

It is noted that, in some embodiments of the invention, the chemicals from containers 132 and 134 are mixed only in exit unit 392, such that foam remnants can settle only within these easily replaced pieces. As lips 508 serve as valves which only allow passage of the chemicals when the chemicals are provided in relatively high pressure streams, the mixed chemicals cannot backflow into suction unit 210. Typically, after each 5-10 uses and/or when the operation is problematic (e.g., the mix is not good, the stream is weak), exit unit 392 is

replaced. In some embodiments of the invention, the mixed chemicals also touch the tip 510 of internal piece 393. Optionally, in these embodiments, internal piece 393 is also easily replaceable, for example every 10-20 or even every 100 uses. Alternatively, chamber 598 is defined closer to nozzle 220, so that the mixed chemicals only touch portions of exit unit 392, which is easily replaceable.

Alternatively to replacing only exit unit 392, internal piece 393 or circular unit 390, nozzle 220 is replaced as a single unit, for simplicity of maintenance. In some embodiments of the invention, nozzle 220 is integral with suction unit 210, such that suction unit 210 and nozzle 220 are replaced together. In some embodiments of the invention, kits including containers 132 and 134, nozzle 220 and suction unit 210 are provided. The elements of the kits are optionally provided assembled, allowing fast replacement of the elements of dispensing gun 120 that come in contact with the chemicals. Thus, whenever there is a problem in operation of gun 120 the user simply replaces a single detachable unit including all the elements that come in contact with the chemicals, and there is no need to analyze the cause of the problem.

In some embodiments of the invention, the chemicals are provided by suction unit 210 at a high pressure, such as between 6-10 atmospheres (e.g., 6.079-10.13 bar), so as to achieve a smooth mix of the chemicals.

Heaters 206 are optionally controlled to achieve a desired chemical heat of the contents of containers 132 and/or 134, such as between about 50-60°. Alternatively, for simplicity, heaters 206 are not controlled and perform the heating according to a predetermined operation pattern and/or the heat transfer characteristics of gun 120. For example, heaters 206 may be operated periodically and/or whenever suction unit 210 is operated. Heaters 206 optionally comprise twisted wire heaters, as is known in the art. Alternatively, other heating apparatus may be used, such as PTC heaters and/or heating rods. In some embodiments of the invention, heaters 206 range along the entire length of body section 202, so as to heat all the material in containers 132 and 134. Alternatively, heaters 206 range only along a portion of body section 202, for example the portion closer to suction unit 210. Optionally, heaters 206 cover substantially the entire circumference of containers 132 and 134, along the length of the containers that they cover. Alternatively, heaters 206 cover only a portion of the circumference of containers 132 and 134, as required to achieve a desired temperature. For example, for simplicity, in some embodiments of the invention, the side from which containers 132 and 134 are inserted into body section 202 is not covered by heater 206. Optionally, the containers are

designed to transfer the heat according to the positions of the heaters in gun 120 and/or recesses 130.

The amount of material pumped from each container is optionally controlled by the rate of rotation of the sets of suction gears 322 and 324 and 362 and 364. Hence, the ratio between the amounts of the mixed materials is defined by the ratio between the sizes of gears 352 and 354. Different chemicals may require different mixing ratios. In some embodiments of the invention, a customer can purchase dispensing system 100 with a plurality of suction units 210 which differ substantively only in the ratios between the radii of gears 352 and 354. Optionally, suction units 210 are easily replaceable according to the customer's needs. For example, a first suction unit 210 may be used for achieving a rigid foam for packaging starters, alternators and/or computers, while a second suction unit 210 is used for a softer packaging, for example for glass dishes. The different suction units 210 may be used with different chemicals or with same chemicals. Alternatively to the customer replacing suction units 210, the replacement is performed by a service station of a supplier of system 100, where suction units 210 or only gears 352 and 354 are replaced.

Fig. 6 is a schematic view of a nozzle 600 of a dispensing gun, in accordance with another exemplary embodiment of the invention. A body portion 602 of the dispensing gun includes two outlets 604 which separately provide streams of the chemicals, optionally of high pressure as discussed above. The streams are combined within nozzle 600 and are provided through an outlet 606. Nozzle 600 is optionally easily connected to body portion 602 so as to allow easy and fast replacement of the nozzle. In some embodiments of the invention, body portion 602 includes protruding plates 610, which receive compatible protrusions 612. Optionally, nozzle 600 is attached to body portion 602 by bringing the nozzle at a small angle to the proximity of plates 610 and rotating the nozzle so that protrusions 612 move into the handles (e.g., using a bayonet connection method). Alternatively, the attachment is performed by squeezing nozzle 600 so that it passes into plates 610.

Alternatively to using passive nozzles 600, nozzles which include suction unit 210 may be used. Thus, replacement of suction unit 210 for different types of foams can be made simple.

Alternatively to providing a mixing chamber 598 in a nozzle connected to the dispensing gun, in some embodiments of the invention, the dispensing gun provides two separate streams of the different chemicals. A mixing chamber is placed in a box to be

packaged and the separate streams are directed at this mixing chamber. The mixing chamber may include a cheap disposable unit, such as a bag.

Fig. 7 is a schematic illustration of a dispensing system 700, in accordance with another exemplary embodiment of the invention. In system 700, the chemicals are held in containers mounted on the gun and not in closed compartments within the gun. Dispensing system 700 comprises a dispensing gun 720 having a port 725 to which a container 701 is connected. Container 701 is optionally divided into two separate compartments 721 and 722, each of which contains a different chemical or chemical mixture. Compartments 721 and 722 may be of the same size or may have different sizes. In an exemplary embodiment of the invention, the ratio of the sizes of compartments 721 and 722 is equal to the mix ratio of the materials they contain when they mix into foam. Thus, both the compartments of container 701 empty out at substantially the same time. It is noted that the orientation of container 701 and port 725 is such that the contents of the container flow down into gun 720 without the need for a pushing mechanism as in the gun of Fig. 2. Levers 709 are optionally used to release container 701 for replacement.

When a trigger 706 is pressed, a valve 707 is opened, and the chemicals from container 701 are allowed to flow through separate channels 702 and 717 to a mixing chamber 704. It is noted that valve 707 may be close to port 725 and remote from mixing chamber 704 as shown in Fig. 7, or valve 707 may be close to mixing chamber 704. Release levers 708 (schematically represented in Fig. 7) allow fast removal of mixing chamber 704 and replacement with a new mixing chamber. Heaters 703 are optionally used to heat the chemicals to a desired mixing and reaction temperature. System 700 is optionally powered by an electrical cord connection 705. Alternatively or additionally, system 700 may be powered by a chargeable or non-chargeable battery.

Optionally, a piston 710 is used to increase the flow of the chemicals toward mix chamber 704. Alternatively or additionally, a suction unit, as described above with reference to Fig. 3, may be used in order to control the flow. It is noted, however, that in some embodiments of the invention, suction is not used and the chemical flow is achieved by the pushing of piston 710 and/or by gravity.

Alternatively to system 700 using a single container 701 having two separate compartments, system 700 may include two separate containers.

Fig. 8 is a schematic illustration of a stand 800 for use with foam dispensing gun 120, in accordance with an exemplary embodiment of the invention. Stand 800 may be used to fill

packaging bags 810 by dispensing gun 120, instead of using gun 120 to directly place the foam in a package. Bags 810 optionally include filling ports 812 which are adapted to fit on a compatible reception port on the bottom side of an arm 820. Above the reception port, arm 820 includes an aperture and/or base which firmly receives gun 120. In some embodiments of the invention, bags 810 are foldable as shown in a bag pile 816. It is noted that stand 800 may be used with dispensing guns other than dispensing gun 120, including guns that induce mixing in the bags.

While gun 120 is of a size allowing it to be hand-held, at least some of the aspects of the present invention are applicable also to other self contained dispensing devices, which are not hand-held, such as table mounted devices. Using a self-contained dispensing device, which has the chemical containers placed therein or mounted thereon, requires less space and is more suitable for a small business than large dispensing devices known in the art.

Fig. 9 is a schematic illustration of a table mounted self-contained foam dispensing device 900, in accordance with an exemplary embodiment of the invention. Dispensing device 900 includes a housing 902 adapted to receive two chemical containers 904 and 906. Optionally, chemical containers 904 and 906 are inserted into housing 902 through a front door 910. Alternatively, the chemical containers are inserted from above or behind. In some embodiments of the invention, control buttons 912 on door 910 are used to control the operation of device 900. A stand 920 is optionally used to hold device 900 on a table or other surface, for convenient use.

Device 900 further includes a pump 914 which pumps required amounts of chemicals from containers 904 and 906 and a nozzle 916 in which the chemicals are mixed in order to generate foam 918. Nozzle 916 may be of any of the types described above, any other type of nozzle known in the art and/or any of the nozzles described in a PCT application titled "Foam Dispenser Nozzle", filed on same date as the present application in the Israel receiving office, and assigned to the assignee of the present application, the disclosure of which is incorporated herein by reference.

While device 900 can be used to direct foam directly into place and/or into bags manually positioned beneath nozzle 916, Fig. 9 shows a bag loading system 930 for conveniently, manually or automatically, placing bags beneath nozzle 916. Bag loading system 930 includes a stick 932 carrying a roll of empty bags and a rack 934 for holding bags open beneath nozzle 916.

Figs. 10A and 10B illustrate a chemical container port 950 for use in a dispensing device, in closed and open states, respectively, in accordance with an exemplary embodiment of the invention. A base flange 952 of port 950 fits on a chemical container, such as containers 132 and 134, and/or a chemical bag. In some embodiments of the invention, a tube receptor 958 sits within port 950 and leads a respective tube 970 of the dispensing device 120, which leads the chemical from the container, through port 950 toward a mixing chamber of the dispensing device. In a closed state of port 950, a diaphragm 960 blocks the passage of chemicals through the port. When tube 970 is inserted into port 950, tube 970 fits over tube receptor 958 and folds diaphragm 960 inwards so as to allow flow of chemicals from the container into the dispensing device in the direction of an arrow 972. In its folded position, diaphragm 960 prevents flow of chemicals out of the container not into tube 970. Upon removal of tube 970 from port 950, diaphragm 960 unfolds and prevents flow of chemicals out of the container.

In some embodiments of the invention, tube 970 is a part of a dispensing device. On an opposite end of port 950 from base flange 952, a lip 954 of the port optionally abuts against the dispensing device. Alternatively, long tubes may lead from container port 950 to the dispensing device.

In some embodiments of the invention, a plastic ring 956 located radially within lip 954, holds diaphragm 960 in place.

In some embodiments of the invention, diaphragm 960 comprises a silicon diaphragm. Alternatively to a silicon diaphragm, any other material may be used for diaphragm 960.

Port 950 is particularly useful in self-contained dispensing devices, in which it is particularly desired to prevent dripping of chemicals. It is noted, however, that port 950 may be used also in other foam dispensing devices.

Fig. 11 is a schematic illustration of a foam generation machine 980, in accordance with an exemplary embodiment of the invention. Machine 980 is adapted for generation of foam bags from plastic bags 982 pre-filled with chemicals. In some embodiments of the invention, bags 982 include two chemical compartments 984 and 986, which include required amounts of chemicals for generating foam. An empty compartment 988 is adapted to receive a mixture of the chemicals from compartments 984 and 986 and has sufficient volume to accommodate the foam resulting from expansion of the mixture. A disposable nozzle 990 is placed between chemical compartments 984 and 986 and empty compartment 988. It is noted that nozzle 990 is emphasized and therefore seems to be above empty compartment 988 rather

than within compartment 988. It will be understood that nozzle 990 is within the compartment 988. Alternatively, tubes (not shown) lead the mixed chemicals from the mixing chamber of nozzle 990 to compartment 988.

Nozzle 990 optionally includes embedded channels 992 which controllably lead the chemicals to a mixing chamber 994 therein. In some embodiments of the invention, nozzle 992 is formed of a flexible, optionally compressible, material which is preset in a closed configuration, such that absent external pressure to open the channels 992, chemicals do not flow through the nozzle. Possibly, a rigid ring (not shown) presses on nozzle 990 so as to keep channels 992 closed.

In order to generate foam, bag 982 is placed by a human user in machine 980, in an orientation in which chemical compartments 984 and 986 are on a heating plate 996. A thermostat 995 optionally prevents the further operation of machine 980, until the chemicals in compartments 984 and 986 are sufficiently heated. Alternatively or additionally, a timer prevents further operation of machine 980, unless bag 982 is within machine 980 for at least a predetermined amount of time. After the chemicals are sufficiently heated, a press piston 998 is pressed down on compartments 984 and 986, for example responsive to actuation of a control 997 by a human, and forces the chemicals through nozzle 990. The pressure from piston 998 pushes chemical streams through channels 992 at a high pressure, partially due to the small cross-section of the channels, such that the chemical streams have sufficient force to open the channels and mix in mixing chamber 994.

The mixing of the chemicals is optionally performed within sufficient time (e.g., less than 15 seconds) in order to allow for insertion of bag 982 into a package before the foam hardens.

Alternatively or additionally to using piston 998 to force the chemicals from compartments 984 and 986 into empty compartment 988, a pump is used to push the chemicals at a sufficient pressure. In an exemplary embodiment of the invention, bag 982 includes a disposable pump incorporated therein. In operation, a motor on machine 980 is connected to gears of the pump so as to operate the pump. Alternatively, a pump on machine 980 is connected to nozzle 990 externally in a manner which induces flow of the chemicals through channels 992. Further alternatively, tubes connecting compartments 984 and 986 to empty compartment 988 are oriented to operate with peristaltic pumps on machine 980. In some embodiments of the invention, one or more rollers may be used to force the chemicals out of compartments 984 and 986.

It will be appreciated that the above described methods may be varied in many ways. It should also be appreciated that the above described description of methods and apparatus are to be interpreted as including apparatus for carrying out the methods and methods of using the apparatus.

The present invention has been described using non-limiting detailed descriptions of embodiments thereof that are provided by way of example and are not intended to limit the scope of the invention. For example, in addition to, or instead of, lips 508, separate pressure valves may be placed along the path to the mixing chamber in order to prevent back flow and/or operation at lower pressures than suitable. It should be understood that features and/or steps described with respect to one embodiment may be used with other embodiments and that not all embodiments of the invention have all of the features and/or steps shown in a particular figure or described with respect to one of the embodiments. Variations of embodiments described will occur to persons of the art.

It is noted that some of the above described embodiments may describe the best mode contemplated by the inventors and therefore may include structure, acts or details of structures and acts that may not be essential to the invention and which are described as examples. Structure and acts described herein are replaceable by equivalents which perform the same function, even if the structure or acts are different, as known in the art. Therefore, the scope of the invention is limited only by the elements and limitations as used in the claims. When used in the following claims, the terms "comprise", "include", "have" and their conjugates mean "including but not limited to".